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A trio of cameras enhance forecasting of sun-generated storms

Solar Mass Ejection Imager experiment significantly improves the prediction of geomagnetic disturbances that hamper communication to the warfighter

Every 100 plus minutes, while orbiting approximately 50 miles above the earth onboard the Coriolis satellite, the Solar Mass Ejection Imager experiment scans the darkness of space seeking sun-generated magnetic clouds of particles intent on striking the planet.

Since becoming operational in January 2003, SMEI's three cameras have photographed over 200 coronal mass ejections, and of that total, approximately 30 have reached the globe, causing a variety of problems including disruption of communication to the warfighter and damaging spacecraft components.

With the SMEI proof-of-concept experiment, accurately forecasting of when and where the destructive clouds of solar particles will impact the Earth has been significantly enhanced.

"The Solar Mass Ejection Imager project represents a collaborative effort that spans eight time zones. It has demonstrated that coronal mass ejections can be detected and tracked from the sun to the Earth and beyond," said Janet Johnston, SMEI program manager, Battlespace Environment Division, Air Force Research Laboratory's Space Vehicles Directorate, Hanscom Air Force Base, Mass. "It has generated a data set never seen before. SMEI photographs the entire sky every 100 plus minutes, and there is no data set on solar storms, or, indeed of the cosmos like that."

During the early 1990s, with an increasing reliance on satellites, the Dept. of Defense initiated space weather forecasts to protect its critical assets in the cosmos. Situated 93 million miles from the Earth, the sun periodically discharges large blobs of plasma and embedded electromagnetic fields, known as coronal mass ejections, traveling at speeds approaching four million miles per hour. The fast and furious solar material can impact the Earth within one to three days after departure. They also trigger geomagnetic storms, which disrupt electric power and communication systems on earth, as well as damage spacecraft circuitry and degrade performance.

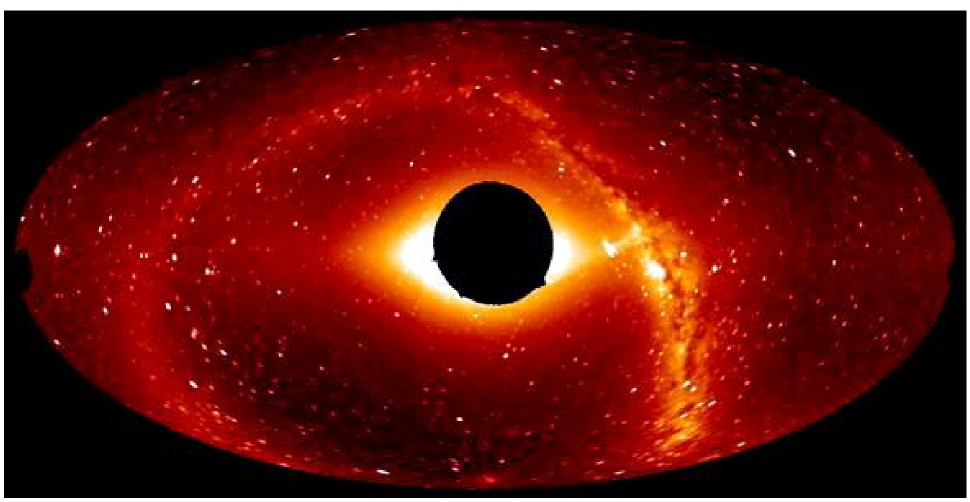
"There were no pictures of these solar-generated disturbances before SMEI. The three cameras on the payload are demonstrating a capability we have never had before," said Ms. Johnston. "Lots of space weather forecasts are made, but the track record is not that good (60 percent are inaccurate). SMEI has demonstrated a 30 percent improvement in the accuracy of forecasts."

In addition to monitoring solar storms, the SMEI trial has observed high-altitude auroras, asteroids, debris, stellar variability and some unique comet tail disconnections. Nevertheless, after snapping pictures of space weather and other occurrences in the cosmos for the past three and a half years, the SMEI has required little upkeep, but the radiation environment it operates in, however, has impacted the quality of the images. On the other hand, SMEI could remain operational for the next three to four years or for as long as the Coriolis satellite, administered by the U.S. Navy, continues its mission. That decision may be impacted by the shelf life of the spacecraft's other onboard payload, Windsat, a Naval Research Laboratory-sponsored experiment, which gathers information on the speed and direction of ocean-surface winds. Regardless, SMEI has set the benchmark for future space weather forecasting.

"We expect in years to come that SMEI will continue to provide a great source of research. We also hope that an operational version of SMEI, which detects and tracks solar disturbances will become a reality," said the SMEI program manager. "SMEI is just part of the space weather forecasting "big picture." To accomplish the task, in addition to reliable detection and tracking of coronal mass ejections, we will need particle sensors in orbit around the sun and methods to predict the incoming magnetic fields. In addition, it will also require a fundamental understanding of the physics of solar processes. We're working on it!"

The three charged couple devices camera trial involves a partnership between the National Aeronautics and Space Administration, the University of California at San Diego, Boston College, Boston University, Montana State University, the University of Birmingham in England, the Air Force's Space and Missile Systems Center and AFRL.

"SMEI has definitely impacted the warfighter by providing improved space weather forecasts, but it has also drawn the defense community's attention to the importance of knowing when and where geomagnetic storms will happen," said Ms. Johnston. "We are also making substantial progress in working with other space weather forecasters to employ SMEI results into prediction models. By combining SMEI data with existing forecasting models, the experiment's observations can provide a "mid-course correction" for the coronal mass ejection that is heading towards the Earth."



An all-sky composite image, taken by the Solar Mass Ejection Imager experiment, displaying the dark 20 degree exclusion zone around the sun, stars, and the Milky Way Galaxy. SMEI's three cameras produce a view of objects in space from 20 degrees out from the sun to behind the Earth. (U.S. Air Force photo)

Coriolis Program patch featuring the Solar Mass Ejection Imager and Windsat payloads. (Courtesy of Janet Johnston)